



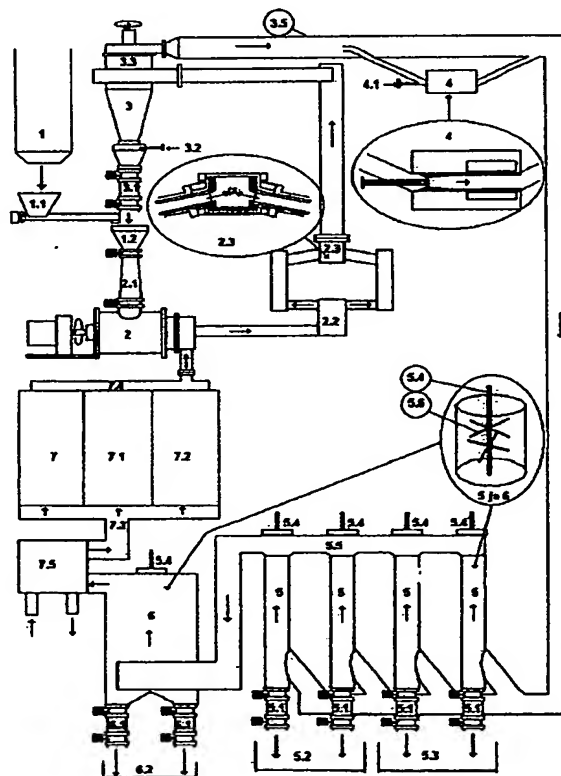
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(54) Title: EQUIPMENT AND METHOD FOR PRODUCING ULTRA FINE DRY POWDERS BY MEANS OF A HIGH-ENERGY POWER GAS

## (57) Abstract

The invention concerns an equipment and a method for producing ultra fine dry powders by means of an energetic power gas using an opposed jet mill (2.3) and a classifier (3) and a device (5, 6) for separating gas and solids connected thereto. The invention is characterized in that the device for separating gas and solids from each other (5, 6) comprises at least one ion jet tube (5, 6) with a concentrically extending high voltage electrode (5.4) provided with a large number of radial ion jet tips (5, 6), whereby the solid particles of the gas solid suspension led at a low speed through the ion jet tube (5, 6) are attached to the inner walls of the tube (5, 6) at the influence of ion jets developed by the ion jet tips (5.6), from which walls the particles are easily recoverable in exactly limited fractions, and the purified power gas is arranged to discharge from the opposite end of the ion jet tube (5, 6), and that in order to control the operation of the equipment an on-line operating measuring and analysing device (4), coupled to a control unit of the equipment, is mounted into the discharge channel (3.5) for the fine fraction in order to determine the particle size and the fineness of the solid particles of the gas-solid suspension flowing through the discharge channel (3.5).



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**EQUIPMENT AND METHOD FOR PRODUCING ULTRA FINE DRY POWDERS BY MEANS OF A HIGH-ENERGY POWER GAS**

5 This invention refers to an equipment and a method for producing  
ultra fine dry powders by means of an energetic power gas. The  
equipment comprises an opposed jet mill with a feeding device and a  
classifier in direct pipe contact with the outlet of the mill, in  
which classifier the ground product will be classified into a coarse  
10 fraction and a fine fraction by means of centrifugal forces, said  
classifier being provided with a separate outlet for each fraction,  
whereby the outlet of the fine fraction is in direct contact with a  
device for separating gas and solid material through a discharge  
channel.

15 In the method the solid substance to be ground is fluidized in a  
high pressurized power gas and the formed gas/solid suspension is  
accelerated through at least two substantially oppositely directed  
acceleration nozzles into a small grinding chamber, in which the  
solid products collide with one another and are ground, the ground  
20 gas/solid suspension is classified substantially by means of  
centrifugal forces into a coarse fraction and a fine fraction and  
the gas/solid suspension of the fine fraction formed is led to a  
device for separating gas and solid material in order to recover the  
final product.

25 All industrial fields from medical industry to mine- and building  
material industry use as raw materials a continuously increasing  
amount of different types of finely ground or micronized powder like  
dry products. The micronizing / fine-grinding of these products is  
30 nowadays generally carried out in jet mills, in which highly  
pressurized air or overheated water vapor is generally used as  
grinding energy. Depending on the final product and the fineness  
thereof the energy consumption of these grinding and classifying  
processes is about 100 to 3000 kWh/ton.

35 At this moment a fine-grinding technique operating according to the  
opposed jet mill principle is considered to be the most effective  
and the most economic fine-grinding method. The opposed jet mill  
technique was developed during the 1980:ies and the 1990:ies  
40 substantially by the Finnish company Oy Finnpulva Ab, by means of  
which technique the energy economy and the grinding effectivity of  
the fine-grinding have been improved considerably. However, a wider  
utilization and application of the developed opposed jet mill

technique has been considerably disturbed by the lack of effective and especially of auxiliary techniques applicable in connection with the opposed jet mill technique and/or their low efficiency and high energy costs.

5

Previously known micronizing devices and methods are especially affected with the below presented basic problems and shortcomings, which undoubtedly will cause a lot of unnecessary energy consumption and will limit the quality of the final products. Said shortcomings will also considerably limit an effective realization of the basic idea of opposed jet grinding.

In fine-grinding/micronizing an energetic power gas, most oftenly pressurized air, is used as grinding energy. The micronizing devices will need industrial compressor effects ranging from 100 kW to 1000 kW depending upon application. Due to the large separate electrical effect the energy consumption in compressing the power gas and in grinding is generally regulated only by regulating the pressure of the gas. Other regulations have not previously been carried out.

The classification of a product ground in an opposed jet mill as well as the methods and the devices previously used to separate the power gas and the solids from each other, are affected by big technical shortcomings. In the separation of solids and power gas from each other, methods and devices using different kinds of filter fabrics have been utilized, which are affected by often appearing obstruction and efflux problems, as well as of an energy consumption caused by pressure differences and, without no exception, a centrifugal fan has to be used in all applications of the separation stage in order to develop pressure differences sufficient for the operation of the device. The finer final product is to be produced, the more expensive and more difficult to control will the classification and the separation processes turn to be. In previously used grinding processes, wherein the size of the particles to be treated was not smaller than 5  $\mu\text{m}$ , such a problem did not appear.

The classification is based on centrifugal forces arising as a result of the flow rate of the power gas/solids and of the rate of rotation of the rotor. The controlling of the classification process has been carried out by regulating the rate of rotation of the rotor as well as of the flow rate of the power gas/solids through the

classifier during an initial stage of the classification procedure, but no continuous regulation has been carried out.

5 Previously the adjustment and the regulation of the grinding and the classifying processes were only based upon watching the set values of the pressure and the temperature. When a deviation is detected and the situation is not returned the regulation is carried out manually. Such a procedure will cause a huge energy loss and product defects. The amount of power gas is held constant namely all the  
10 time and the pressure is adjusted by changing the amount of solids fed to the acceleration nozzles or possibly by blowing a part of the power gas past the grinder. Hereby also the gas/solid ratio, which is essentially important to the grinding, will also be changed, which cannot be acceptable.

15

The object of the present invention is to eliminate the above mentioned problems. This is achieved by an equipment, which is characterized in that the device for separating gas and solids from each other comprises at least one ion jet tube with a concentrically  
20 extending high voltage electrode provided with a large number of radial ion jet tips, whereby the solid particles of the gas solid suspension led at a low speed through the ion jet tube are attached to the inner walls of the tube at the influence of ion jets developed by the ion jet tips, from which walls the particles are easily  
25 recoverable in exactly limited fractions, and the purified power gas is arranged to discharge from the opposite end of the ion jet tube, and that in order to control the operation of the equipment an on-line operating measuring and analysing device, coupled to a control unit of the equipment, is mounted into the discharge channel for the  
30 fine fraction in order to determine the particle size and the fineness of the solid particles of the gas-solid suspension flowing through the discharge channel.

The method according to the invention is characterized in that  
35 separation of the solid material from the gas/solid suspension of the fine fraction is carried out by means of a high voltage current in one or more ion jet tubes, to which the gas/solid suspension is led at a low speed, whereby the solid particles at the influence of ion jets are forced against the inner walls of the tube, to which  
40 they are attached, and wherefrom they are easily recovered in exactly limited fractions, and the thus purified power gas, free of solids leaves the tube at the other end, and in order to control each operation of the method the particle size and the fineness of

the solid particles of the gas/solid suspension of the fine fraction are continuously determined by an on-line operating measuring and analysing device, the measuring results of which are led to a control unit in order to develop control signals.

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By means of the invention the energy economy and the efficiency of the fine-grinding can be considerably improved, the environmental load can be decreased, and special products with a higher fineness than earlier can be produced, e.g. a product having a fineness of even a nano level. By means of this invention the energy consumption of a fine-grinding and a micronizing process can, depending upon the application, be decreased to about 30 to 50 % from the values of earlier applications.

15 Further features of the invention will appear from the attached dependent claims.

Below the invention will be described more in detail, with reference to the attached drawings, wherein

20

figures 1 to 3 disclose schematically three embodiments of an equipment of the invention, provided with partially enlarged sections of the opposed jet mill, of the measuring and analysing device and of the ion jet tube.

25

The material to be ground/micronized is fed from a feeding tank 1 of the equipment for instance by means of a screw feeder or a lock feeder 1.1 to a supply hopper 1.2 at the top of a double valve feeder 2.1 operating as a feeder device of an equalizing tank 2 of an opposed jet mill. From the supply hopper the material is fed by means of the double valve feeder 2.1 in portions to the equalizing tank 2, wherein a static pressure required for the grinding is maintained. By means of a screw feeder or a rotor the material is transposed from the equalizing tank 2 into a flowing, energetic power gas, developed in a compressor device 7, 7.1 and 7.2 in order to form a suspension of the gas and the solid particles. The suspension of the gas and the solid particles is led through a dividing device 2.2 and at least two substantially oppositely directed acceleration nozzles into a small grinding chamber 2.3, wherein the particles to be ground collide against one another and are crushed-/ground almost autogenically. In the grinding chamber a slight superpressure is maintained, said chamber being in direct pipe contact with a dynamically operating cyclone-rotor classifier 3 of

40

the equipment. The gas suspension of the ground material is fed to the cyclone-rotor classifier 3 through a special spiral part, in order to equalize the flow of the gas-solid suspension with respect to a rotor portion 3.3 of the classifier. In the cyclone-rotor classifier 3 the ground material is classified by means of centrifugal forces into a fine fraction and a coarse fraction. The coarse fraction is removed through a double valve feeder 3.1 mounted at a lower end of a conical part of said cyclone-rotor classifier. In the shown embodiment the coarse fraction is recycled to the hopper 1.2 of the opposed jet mill for regrinding, but in some cases the coarse fraction can be recovered as a separate final product. The fine fraction discharges as a gas-solid suspension through the rotor portion 3.3 at the top of the classifier into a discharge channel 3.5. The fine fraction is led through the discharge channel 3.5 to a device 5, 6 for separating the power gas and the solid particles from each other, in order to recover a final product.

According to the invention the device for separating gas and solids from each other comprises at least one ion jet tube 5 having a concentrically extending electrode 5.4 provided with a large number of radial ion jet tips 5.6, to which electrode a very high direct-current voltage is fed. The gas-solid suspension of the fine fraction is led at a low speed through the ion jet tube 5, 6, whereby the solid particles influenced by ion jets are forced against the inner walls of the ion jet tube 5, 6, to which walls they are attached, and the thus purified power gas, free of solid particles, discharges from the opposite end of the tube 5, 6. The solid particles are easily removable from the walls of the ion jet tube 5, 6 in some cases by utilizing gravitation forces only, but the tube may also be provided with a mechanical cleanser, a vibrator or washing dyes. The solid particles will preferably discharge through a double valve 5.1, 6.1 at the lower end of the tube into recovery tanks 5.2 and 5.3 as well as 6.2, if the tube is vertical or possibly by means of a screw conveyor or conveyors if the tube is horizontal. From the horizontal tube the separated solid material can be removed at different points and in different qualities by means of screw conveyors.

To the equipment can several ion jet tubes be connected parallel and/or in series, if required, whereby the electric fields and voltages of each tube can be separately adjusted so that from different tubes different products or products of different quality are received. Thus the equipment can also be used for further frac-

tioning of the the fine fraction. Control signals for different control parameters of the ion jet tubes can be based on measuring signals sent by a measuring and analysing device. The voltage of current necessary for developing the ion jets is preferably ranging from 50 to 200 kV and the intensity of current is only a few milliamperes. The voltage range is chosen from case to case. The product fractions of different finenesses separated from the equipment can be removed either as dry powders or as sludges, and some fraction can be recycled for instance to the grinding unit for a new treatment.

In the embodiment according to fig. 1 the separating device 5 comprises four parallelly coupled ion jet tubes 5, in which two different kinds of products are aimed to be recovered from the fine fraction into a tank 5.3 and a tank 5.2, respectively. The purified power gas, free from solid particles is led through a common gas removing pipe 5.5 directly to a compressor or a compressor group 7, 7.1, 7.2, used to pressurize the power gas of the equipment. In the embodiments disclosed in figures 2 and 3 the separating device further comprises an accessory unit 6 connected in series to the ion jet tubes 5, in order to make sure that the discharged air is really pure or to further classify the fine fraction. In said unit the flowing rate of the gas can be decreased, whereby the power gas will become almost absolutely pure and often a very valuable solid material, having a nano level fineness. can be recovered through double valves 6.1, mounted under the accessory unit 6 into a product tank 6.2.

According to the invention an on-line operating measuring and analysing device 4 is provided to determine the particle size and the fineness of the solid particles in the gas-solid suspension flowing through the discharge channel 3.5 in order to regulate different operations of the equipment. The measuring signals developed by the measuring and analysing device 4 are led to a control unit of the equipment, which unit, based on these signals is arranged to develop control signals for different operations of the equipment.

The measuring and analysing device 4 is preferably mounted into a branch tube extending parallel to the discharge channel of the fine fraction and provided with an ejector pump 4.1, which branch pipe downstreams the measuring and analysing device 4 again will join the discharge channel 3.5. By means of a pressure difference developed by the ejector pump 4.1 a representative partial flow of the gas-



solid fraction flowing through the discharge channel 3.5 is drawn into the measuring and analysing device 4. At the same time the gas-solid suspension can, when required, be diluted to a correct level for the measuring operation.

5

The measuring and analysing device 4 comprises preferably a unit, the operation of which is based on scattering of a laser beam i.e. laser diffractometry, for defining the amount of the coarser particles in the final product and the average particle size

10 thereof, as well as a unit, the operation of which is based on the doppler effect of the particles, for defining the amount of the small and the ultra fine particles in the final product and the specific surface of the final product.

15 In the solution according to figure 2 the purified power gas is led, as in figure 1, to the compressor group 7, 7.1, 7.2, however not until it has been cooled in a cooling unit 7.5, whereby the power gas is in a closed circuit, and special purification and treatment of any feed air can be avoided. Hereby i.e. the aromas of aromatic  
20 materials are preserved in the process and will not escape with a changing power gas.

In the solution according to figure 3 the purified warm power gas is led through a channel 6.3 to other purposes, such as heating or  
25 drying.

Preferably new or recyclable power gas is pressurized in compressor units 7, 7.1, 7.2 operating parallelly, of which at least one unit is provided with a regulation system for the rate of rotation i.e.  
30 the air yield, such as an inverter. The operation of the said adjustable compressor unit/units is regulated by control signals developed based on measuring signals from the measuring and analysing device 4, at the same time as the other compressors are arranged to operate at a constant rate of rotation and yield at their optimal  
35 operating point. In this way the energy amount to be used for the development of the power gas can be optimized as required by the micronizing process. The power gas, pressurized by the compressor group, can if necessary be cooled in a cooling unit 7.4.

40 At the lower end of the conical part of the cyclone-rotor classifier 3 of the equipment washing air nozzles are arranged, to which low pressure washing air is fed through a feed connection 3.2. By means of the washing air the amount of the fine fraction, discharging from

the classifier 3 through the double valve feeder 3.1 together with the coarse fraction, can be regulated. The amount of superlarge or coarse granules in the fine fraction can be adjusted by regulating the periphery speed of the rotor 3.3 of the classifier. Both the  
5 feed of the washing air and the periphery speed of the rotor can advantageously be regulated by means of control signals developed by the control unit based upon measuring signals received from the measuring and analysing device 4.

10 The on-line operable measuring and analysing device 4 according to the invention can thus be used for instance for regulating the amount of the power gas, for regulating the amount of the raw material, for regulating the amount of the washing air to be fed to the classifier, for regulating the periphery speed of the rotor in the  
15 classifier, for regulating the mass of the particles in the grinding chamber, for regulating the electrical voltage of the separating device, for regulating the flow-through rate of the gas/solid suspension in the separating device and for regulating the dosage of additives to the final product. The most economical way of changing  
20 the speed of the particles to be ground in the acceleration nozzles is to regulate the amount of power gas and the solids based upon obtainable on-line analytical data of the quality of the final product.

25 At special occasions and in some applications it may be preferable to connect a mechanical filter or a washer to the gas removing channel 5.5 for the power gas leaving the ion jet tube 5 and/or 6. Such a solution is necessary for instance during a sudden current interruption or in a case where the power gas has been in contact  
30 with chemically active particles.

Because the ion jets will change the electrical surface charges of the solid particles, said phenomena can be utilized during further processing of the micronized material. For instance particles of  
35 minerals, having natural hydrophobic properties, which particles are used in the paper manufacturing industry, will be changed to hydrophilic by the influence of ion jets. Hereby a micronized mineral powder of this type can be sludged to a high solid content without further energy use and the stability of the sludge will remain good  
40 without considerable use of special chemicals. The sludging can be carried out as a continuous purifying/washing operation of the separating device, because the amount, the quality and the flow rate of the solid material are known constant values.

By means of the present invention ultra fine powders can be produced considerably more effectively and economically than before from different dry and moist raw materials, when the final products have a

5 D98 particle size of 0,3 $\mu$ m to 150 $\mu$ m, and an average or D50 particle size of 0,01 $\mu$ m to 30 $\mu$ m.

The developed equipment and method can very well be used in separating, enriching and dry enriching of different types of e.g. minerals, metals and organic materials as well as in the production of

10 crystal seed used by different industrial areas. The method will also make it possible to produce final products having a finer particle size than previously, i.e. at the nano level from solid raw materials.

## CLAIMS

1. Equipment for producing ultra fine dry powders by means of an  
5 energetic power gas, which equipment comprises an opposed jet mill  
(2.3) with feeding devices (1, 1.1, 1.2, 2.1, 2, 2.2) and a classi-  
fier (3) in direct pipe contact with the outlet of the jet mill  
(2.3), in which classifier the ground product will be classified  
10 into a coarse fraction and a fine fraction by means of centrifugal  
forces, said classifier (3) being provided with a separate outlet  
for each fraction, whereby the outlet of the fine fraction is in  
direct contact with a device (5, 6) for separating gas and solid  
material through a discharge channel (3.5), **characterized** in that  
15 the device for separating gas and solids from each other (5, 6)  
comprises at least one ion jet tube (5, 6) with a concentrically  
extending high voltage electrode (5.4) provided with a large number  
of radial ion jet tips (5.6), whereby the solid particles of the gas  
solid suspension led at a low speed through the ion jet tube (5, 6)  
20 are attached to the inner walls of the tube (5, 6) at the influence  
of ion jets developed by the ion jet tips (5.6), from which walls  
the particles are easily recoverable in exactly limited fractions,  
and the purified power gas is arranged to discharge from the oppo-  
site end of the ion jet tube (5, 6), and that in order to control  
25 the operation of the equipment an on-line operating measuring and  
analysing device (4), coupled to a control unit of the equipment, is  
mounted into the discharge channel (3.5) for the fine fraction in  
order to determine the particle size and the fineness of the solid  
particles of the gas-solid suspension flowing through the discharge  
30 chanel (3.5).
2. Equipment according to claim 1, **characterized** in that the equip-  
ment comprises several in parallel och/or in series connected ion  
jet tubes (5, 6) the electrical fields and voltages of which are  
individually regulated controlled by measuring signals provided from  
35 the measuring and analysing device (4).
3. Equipment according to claim 1, **characterized** in that the ion jet  
tube (5, 6) is provided with mechanical scrapers, vibrators or  
washingdies as well as double valves (5.1, 6.1) at the bottom of the  
40 tube in order to remove the solid particles attached to the inner  
walls of the ion jet tube (5, 6).

4. Equipment according to claim 1, **characterized** in that the gas removing channel (5.5) for the purified power gas free of solids leaving the ion jet tube (5, 6) is led directly to a compressor or a group of compressors (7, 7.1, 7.2) used for developing power gas.

5

5. Equipment according to claim 1, **characterized** in that the measuring and analysing device (4) is mounted into a branch pipe extending in parallel with the discharge channel (3.5) for the fine fraction and provided with an ejector pump (4.1), which branch pipe downstreams the measuring and analysing device (4) again joins the discharge channel (3.5).

6. Equipment according to claim 5, **characterized** in that the measuring and analysing device (4) is provided with a unit, the operation of which is based on scattering of a laser beam, i.e. laser diffractometry, for determining the amount of the coarser particles in the final product and the average particle size thereof, as well as with a unit, the operation of which is based on the doppler effect of the particles, for determining the amount of small and ultra fine particles in the final product.

7. Equipment according to claim 4, **characterized** in that the gas removing channel (5.5) is led to the compressors (7, 7.1, 7.2) via a mechanical filter and/or a gas washer.

25

8. Equipment according to claim 4, **characterized** in that it is provided with several in parallel connected compressors (7, 7.1, 7.2), of which at least one is provided with a regulating system for the speed of rotation i.e. the yield of the power gas, which system is arranged to receive control signals developed by the control unit based on measuring signals sent from the measuring and analysing device (4), simultaneously as the other compressors are arranged to operate at a constant speed of rotation and yield at their optimal point of operation.

35

9. Equipment according to claim 1, **characterized** in that the classifier (3) of the equipment is a dynamically operating cyclone-rotor classifier being provided with a feed connection (3.2) for low pressure washing air at the lower end of a conical part of said classifier, above a discharge valve (3.1) for the coarse fraction and with a rotor (3.3) with adjustable speed of rotation at the top of the classifier (3) in connection with the outlet of the gas-solid sus-

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pension of the fine fraction, said rotor being arranged to receive control signals from the control unit of the equipment based on measuring signals from the measuring and analysing device (4).

5 10. Method for producing ultra fine dry powders by means of an energetic power gas, in which method a solid material to be ground is fluidized into a high pressurized power gas and the such generated gas/solid suspension is accelerated through at least two substantially opposedly directed acceleration nozzles into a small  
10 grinding chamber (2.3), wherein the solids collide against one another and are ground, the ground gas/solid suspension is classified substantially by means of centrifugal forces into a coarse fraction and a fine fraction, and the gas/solid suspension of the formed fine fraction is led to a device (5, 6) for separating the  
15 gas and the solid material in order to recover a final product, **characterized** in that separation of the solid material from the gas/solid suspension of the fine fraction is carried out by means of a high voltage current in one or more ion jet tubes (5, 6), to which the gas/solid suspension is led at a low speed, whereby the solid  
20 particles at the influence of ion jets are forced against the inner walls of the tube (5, 6), to which they are attached, and wherefrom they are easily recovered in exactly limited fractions, and the thus purified power gas, free of solids leaves the tube (5, 6) at the other end, and in order to control each operation of the method the  
25 particle size and the fineness of the solid particles of the gas/solid suspension of the fine fraction are continuously determined by an on-line operating measuring and analysing device (4), the measuring results of which are led to a control unit in order to develop control signals.

30

11. Method according to claim 10, **characterized** in that the separation of solid particles of different size, even of nano level size, and of different qualities from the gas takes place in different ion jet tubes (5, 6) or at different points in the ion jet tube or tubes  
35 (5, 6) by maintaining different high voltage current fields at these.

12. Method according to claim 11, **characterized** in that the operation situations of the ion jet tube or tubes (5, 6) are regulated  
40 based on results received from continuously carried out measuring and analysing of the gas/solid suspension of the fine fraction.

13. Method according to claim 10, **characterized** in that solid particles are removed from the ion jet tube (5, 6) mechanically or by washing.
- 5 14. Method according to claim 10, **characterized** in that the purified power gas leaving the ion jet tube or tubes (5, 6) is recirculated directly as feed gas to a compressor or a set of compressors (7, 7.1, 7.2) used to pressurize the power gas, possibly after cooling.
- 10 15. Method according to claim 14, **characterized** in that the speed of rotation of at least one compressor (7, 7.1, 7.2) pressurizing the power gas is regulated based on measuring signals received from the continuous measuring and analysing of the gas/solid suspension of the fine fraction.
- 15 16. Method according to claim 10, **characterized** in that during the classification of the ground gas/solid suspension low pressurized washing air is led to the cyclone type classifier (3) near the outlet of the coarse fraction, for rinsing fine particles possibly  
20 present in the coarse fraction into the rotating air flow in the cyclone (3) simultaneously as the passage of coarse particles to the outlet of the fine fraction is prevented by an adjustably rotating rotor (3.3) at said outlet of the fine fraction, whereby the feed of washing air as well as the speed of rotation of the rotor (3.3) are  
25 regulated based on results received from continuous measuring and analysing of the gas/solid suspension of the fine fraction.
- 30 17. Method according to any of claims 10 to 16, **characterized** in that the amount of the power gas, the amount of raw material, the amount of washing air to be fed to the classifier (3), the peripheral speed of the rotor (3.3) of the classifier, the mass of the particles in the grinding chamber (2.3), the currence voltage of the separating device (5, 6) the flow-through speed of the gas/solid suspension in the separating device (5, 6) and the dosage of additives which possibly are to be added to the final product are regulated based on results received from the measuring and analysing of the gas/solid suspension of the fine fraction.
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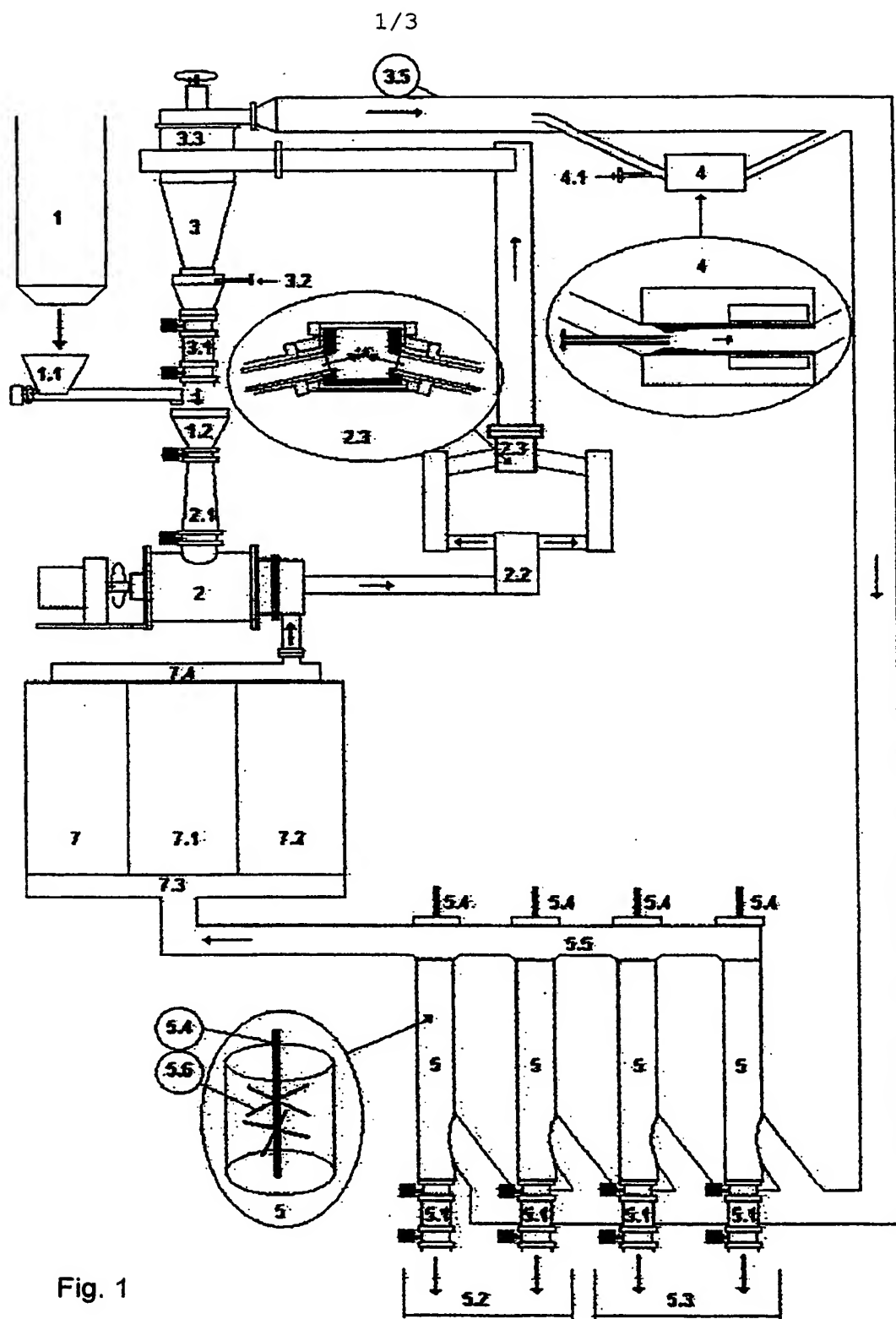


Fig. 1



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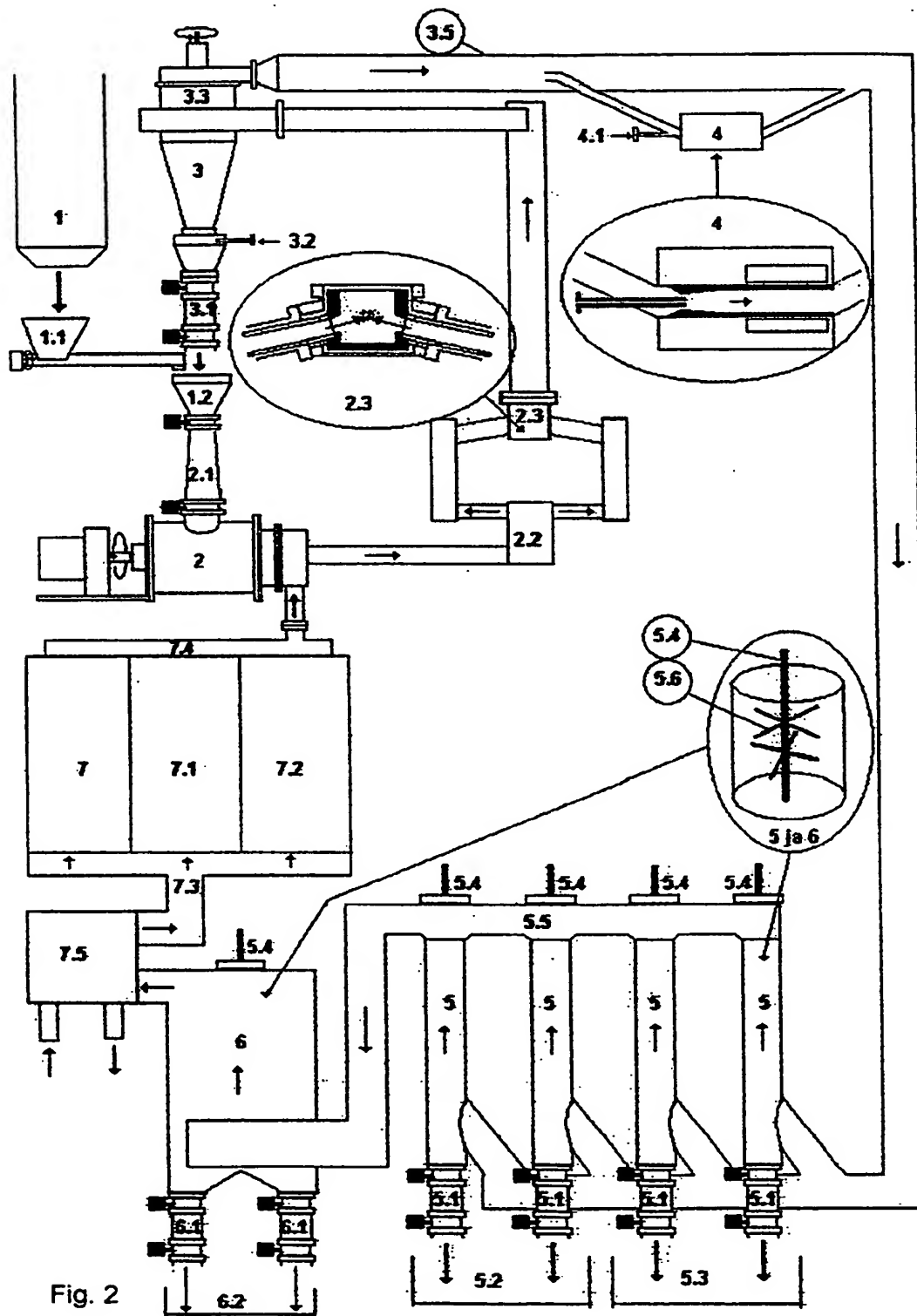
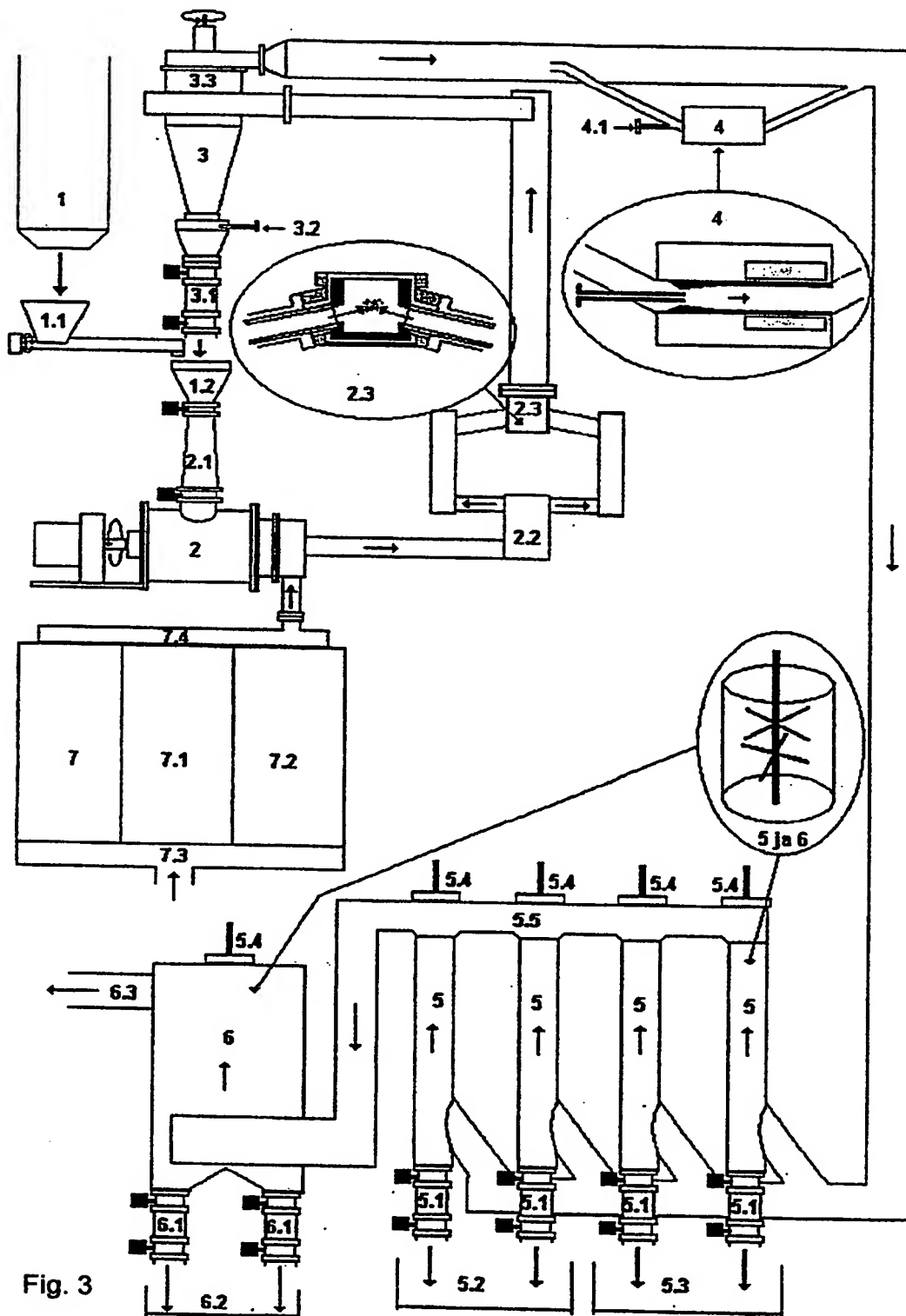


Fig. 2

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 98/00160

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B02C 19/06, B02C 23/08 // B02C 025/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B02C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC, PAJ, US FULLTEXT

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 8801906 A1 (LAROX OY), 24 March 1988 (24.03.88), figure 3, abstract  --	1,10
A	DE 4300861 A1 (BÜHLER AG, UZWIL CH), 19 August 1983 (19.08.83), figures 1,2, abstract  -- -----	1,10

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

\* Special categories of cited documents:

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Date of the actual completion of the international search

15 June 1998

Date of mailing of the international search report

24-06-1998

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

09/06/98

International application No.

PCT/FI 98/00160

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 8801906 A1	24/03/88	AU 6727587 A	07/04/88
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